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ABSTRACT

Linear regression models that predict faculty salaries from professional and affirmative action variables were developed to validate promotion and merit criteria, set a starting salary scale, and identify possible systematic and individual salary inequities. All 377 full-time teaching faculty and librarians (309 men and 68 women) employed by a public four-year college in fall 1981 were investigated. Four stepwise multiple regression analyses were performed. Rank, age, year of appointment, department chair status, librarian status, and sex all affected salary significantly; while tenure, race, and citizenship did not. Contrary to hypothesis, removing rank and tenure from the model did not unmask a sex effect. The uses of regression models in studying faculty salaries are discussed, as are the following five weaknesses: (1) the validity of the model is affected by the choice of variables, (2) variables of interest may be difficult to operationalize, (3) regression analysis assumes all data are linear, (4) regression models with a large number of predictors have relatively poor power, and (5) intercorrelations among the independent variables may mask the true relationship between the variables and salary. (Author/SW)

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Using Regression Analysis to Determine Inequities in Faculty Salaries

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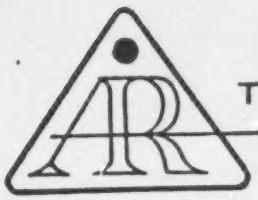

THE ASSOCIATION FOR INSTITUTIONAL RESEARCH

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D. R. Coleman, Chairman
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Abstract

Linear regression models predicting faculty salaries from professional and affirmative action variables were developed to validate promotion and merit criteria, set a starting salary scale, and identify possible systematic and individual salary inequities. Rank, age, year of appointment, department chair status, librarian status, and sex all affected salary significantly; tenure, race, and citizenship did not. Contrary to hypothesis, removing rank and tenure from the model did not unmask a sex effect.

Using Regression Analysis to Determine Inequities in Faculty Salaries

Stepwise multiple regression has become the most common means of analyzing salaries (Swarr, Note 1). Published research on regression models of faculty salaries has covered three areas: the development of the models, their uses, and their weaknesses.

The Development of Regression Models

Regression models differ substantially from one study to the next. The chief source of variation stems from the selection of predictor variables to be included in the model. The most common factors included are rank, academic discipline, and academic experience (Prather & Posey, 1981).

Academic experience is operationalized by examining variables such as highest degree, years since highest degree, years in rank, and age. These factors are frequently non-linear and are therefore often represented in the regression model as age or years squared (e.g., Hurley, Brown, & Schmidtlein, 1981; McLaughlin, Smart, & Montgomery, 1978; Tuckman & Tuckman, 1976). Hurley et al note that additional measures of academic experience such as number of publications and prestige of one's graduate institution often contribute little more to the precision of the model, but such measures are nonetheless considered in some studies (e.g., Katz, 1973; Marshall & Perrucci, 1981; McLaughlin et al, 1978).

Other factors that appear to be frequently studied are affirmative

action variables such as sex and race (e.g., Greenfield, 1977; Hurley et al, 1981; Prather & Smith, 1974) and administrative duties (e.g., Katz, 1973; Prather & Posey, 1981; Schwab & Dyer, 1979).

The variables one chooses to study should of course depend on the purpose of the study. Factors such as sex and race should be included in models designed to determine inequities in these regards but not in models designed to set a starting salary scale. Prather and Posey (1981) note that "to simply use a pre-packaged model is dangerously naive" (p. 5).

The Uses of Regression Analysis in Studying Faculty Salaries

The subject of developing models of faculty salaries has been widely promoted (e.g., Scott, 1977; Pezzullo & Brittingham, 1979), but its application within individual institutions has been less frequently discussed (Prather & Posey, 1981). Possible uses of regression models fall into four categories:

1. Validating promotion and merit criteria. Criteria for promotion, merit, and even starting salary offers are always subjective and thus frequently vague. Often actual criteria do not match policy: a campus that stresses teaching over reseach, for example, may unconsciously grant more merit increases to publishing faculty than to excellent teachers. Another campus may unconsciously favor senior faculty over junior members. Regression analysis can clarify and highlight criteria that evaluators implicitly use in making these kinds of subjective decisions (Katz, 1973; LaMotte & McWhorter, 1981).

2. Determine systematic inequities. It appears from the literature that the most common use of regression models of faculty salaries is

to identify possible sex and racial inequities (e.g., Greenfield, 1977; Hurley et al, 1979; Pezzullo & Brittingham, 1979; Prather & Smith, 1974). Indeed, Hengstler, Muffo, and Hengstler (1982) note that multiple regression is "perhaps the most effective model in analyzing sex discrimination in faculty salaries" (p. 21).

3. Determining individual inequities. Regression analysis pinpoints those individuals whose actual salaries are far different from colleagues with similar characteristics. This permits decision makers to facilitate reviews by focusing on the exceptional cases. Funds for discretionary salary increases can then be allocated in such a way as to reduce the inequities disclosed by the model. If widely disseminated, regression findings can work in the opposite fashion as well; they can show individuals who feel they are being underpaid whether this is indeed true (Prather & Posey, 1981).

4. Establishing a starting salary scale. This is one application of regression analysis that has not been addressed in the literature. Indeed, Prather & Posey (1981) stress that "multiple regression models should not be a substitute for the decision maker" (p. 26) and should not be used to set salaries. It nonetheless seems that a logical use of regression models would be to develop a range of possible starting salaries that could be used as a guide to the decision maker.

The Weaknesses of Regression Models of Faculty Salaries

Anyone who is thinking of using regression analysis to determine inequities in faculty salaries should consider the weaknesses of this approach. At least five have been identified in this literature:

1. The validity of the model is affected by the choice of variables. Hengstler et al (1982) note that one must take into account all appropriate variables while being sure to exclude all inappropriate ones.

2. Variables of interest may be difficult to operationalize. As mentioned earlier, the typical regression model relates salary to rank, academic discipline, and academic experience. The assumption is that rank, for example, reflects teaching ability, scholarship, and service (Prather & Posey, 1981), an assumption that may not be true. Virtually every variable of interest in a salary inequity study has similar problems. Tuckman and Tuckman (1976), for example, describe the numerous measurement problems with publication information.

3. Regression analysis assumes all data is linear. Many of the variables of interest are not interval or ratio (e.g., rank, academic discipline, institutional prestige) and therefore must be dichotomized or have linearity imposed upon them if they are to be used in the model.

4. Regression models with a large number of predictors have relatively poor power (Prather & Posey, 1981). McLaughlin et al (1978), Schwab and Dyer (1979), and Tuckman and Tuckman (1976) all use a very large number of predictors, many of them dichotomous "dummy" variables, without considering the statistical or practical implications of this approach. In addition to the power problem, there is also the concern that a salary predictor model can be sensitive to a few large deviations on relatively unimportant variables. A further concern with these "mega-models" is that frequently nearly all the predictor variables are reported as statistically significant especially when the model is developed from a large sample. In these

circumstances attempts must be made to clarify the relative importance of the significant variables and determine which ones have genuine practical significance.

5. Intercorrelations among the independent variables may mask the true relationship between them and salary (Hengstler et al, 1982). Academic rank is an example of a variable with this kind of problem. As noted earlier, it is frequently used in salary models and it is the strongest predictor of salary (Prather & Posey, 1981). This should not be surprising, however, since salary raises, promotions in academic rank, and tenure status are all granted because of basically the same criteria (Hurley et al, 1981). Introducing academic rank into the model may thus obscure relationships between salary and other factors and mask evidence of sex inequity (Hengstler et al, 1982).

This study had two purposes. The first was to demonstrate via case study that a campus can develop a set of models of faculty salaries from a limited data base that can be used in the four applications described earlier. The second purpose of the study was to investigate the effect of academic rank and tenure on models of faculty salaries.

Method

Subjects

All 377 full-time teaching faculty and librarians employed by a public four-year college in the Northeast in Fall, 1981, were included in the study. The subjects consisted of 309 men and 68 women.

Procedure

In addition to salary, factors studied included:

1. Current academic rank (distinguished professor, professor, associate professor, assistant professor, instructor, and lecturer) and current type of appointment (tenured, tenure-track, and temporary).

2. Academic discipline. Since, as noted earlier, introducing dichotomous variables for each academic discipline would reduce the power of the models, the only variable introduced was librarian status (librarian/non-librarian).

3. Academic experience. This was measured by year of first appointment to the college, highest degree earned, and year of birth. Year of birth was used as a proxy measure of previous experience, since more direct data on this factor was not readily obtainable. Year of first appointment squared and year of birth squared were also included in the model.

4. Administrative experience. The only readily obtainable information in this area was summarized into the dichotomous variable department chair (current or previous chair/never a chair).

5. Affirmative action variables included sex, race (white/non-white), and citizenship (U.S. citizen/non-citizen).

After the data were collected and verified, four stepwise multiple regression analyses were performed. The first one, designed to validate current promotion and merit criteria and develop a starting salary scale, introduced all variables except the affirmative action ones. The second model, designed to identify possible systematic and individual salary inequities, introduced all variables including the affirmative action ones.

The final two models, designed to investigate the effect of rank and tenure on the findings, were the same as the first two except that rank and appointment type were excluded.

In all models, the regression analysis was stopped at the point where additional variables failed to contribute significantly to the model.

Results

The four models, summarized in Table 1, provided information on the validity of merit and promotion criteria, possible systematic and individual salary inequities, and the effect of rank and tenure on the models.

Table 1

Salary Predictor Models

Variable	Standardized regression coefficient	F	Percent of additional variability explained
Model 1: Validating merit and promotion criteria and setting starting salary scales (df=1,370)			
Rank	.507	226.289*	66.92%
Year of birth	- .238	46.510*	8.52%
Year of campus appointment	-2.040	32.962*	2.31%
Department chair status	.134	30.558*	1.92%
Year of campus appointment squared	1.851	26.316*	1.14%
Librarian status	- .096	17.555*	0.87%

Model 2: Identifying systematic and individual salary inequities (df=1,369)			
Rank	.502	225.048*	66.92%
Year of birth	- .241	48.192*	8.52%
Year of campus appointment	-2.132	36.182*	2.31%
Department chair status	.127	27.339*	1.92%
Year of campus appointment squared	1.949	29.273*	1.14%
Librarian status	- .085	13.679*	0.87%
Sex	- .060	6.652*	0.33%
Models 3 and 4: Models 1 and 2 with rank and tenure excluded (df=1,372)			
Year of campus appointment	- .445	117.044*	58.86%
Year of birth	- .313	57.022*	6.43%
Department chair status	.202	48.294*	4.75%
Highest degree	.164	33.822*	2.50%

*$p<.01$

Validation of Merit and Promotion Criteria

If merit and promotion criteria are valid, one would expect significant correlations among salary, rank, appointment type, year of campus appointment, and year of birth. The absolute correlations among these variables ranged from .51 to .82, all significantly greater than zero ($p<.01$).

One would also expect at least some of these variables to be significant factors in a model predicting salary (because of high intercorrelations, one would not necessarily expect all of these variables to make a significant

contribution). The first model, which considered all variables except the affirmative action ones, explained 82% of the variability in salary ($F(6,370)=274.83$, $p<.01$). Rank, year of birth, and year of campus appointment made the most significant contributions to the model, followed by department chair status, year of campus appointment squared, and librarian status. Highest degree, year of birth squared, and appointment type did not explain significant additional amounts of variability.

Development of a Starting Salary Scale

The first model was also used to develop a starting salary scale based on the significant factors of rank, year of birth, year of campus appointment, department chair status, year of campus appointment squared, and librarian status. The scale was developed by using the current year as the year of campus appointment and assuming new faculty are not hired as department chairs. Separate tables were prepared for teaching faculty and librarians. For the most likely combinations of rank and age, a range of possible starting salaries were computed from the predicted salary plus and minus one standard error. The suggested starting salary range for a 35-year-old assistant professor, for example was between $15,421 and $20,749. In sharing this information with academic officials, it was stressed that even these ranges constituted only the most general of guidelines and were no substitutes for personal decisions.

Evidence of Systematic and Individual Salary Inequities

The second model, which considered all variables including the affirmative action ones (sex, race, and citizenship), explained 82% of the variability in salary ($F(7,369)=240.12$, $p<.01$). As in the first model, rank, year of

birth, year of campus appointment, department chair status, year of campus appointment squared, and librarian status made the most significant contributions to the model. They were followed, however, by sex, which made a small but statistically significant contribution, explaining 0.33% of additional variability. Highest degree, year of birth squared, appointment type, race, and citizenship all did not explain significant additional amounts of variability.

The analysis identified 19 faculty members (5% of those studied) whose actual salaries differed from those predicted by at least two standard errors. This is the proportion one would expect from any model. Information on these "outliers" was referred to administrative officials for further evaluation, along with the caution that any model will identify some outliers and their presence does not automatically indicate inequity exists.

The Effect of Rank and Tenure on Salary Predictor Models

The last two models considered the same variables as the first two models except that rank and appointment type were excluded. In both of these models, an identical set of variables made significant contributions: year of campus appointment, year of birth, department chair status, and highest degree. These factors explained 73% of the variability in salary ($F(4,372)=245.71$, $p<.01$). Year of birth squared, year of appointment squared, librarian status, and, when considered, the affirmative action variables (sex, race, and citizenship) did not make significant contributions.

Discussion

The findings of this study concur with those discussed earlier in that variables measuring rank, academic discipline, academic experience, and administrative experience all contributed significantly to explaining variability in salary.

The study also showed how a campus can use a faculty salary model to validate promotion and merit criteria, develop a starting salary scale for newly-hired faculty, and identify possible inequities in salary.

The findings of this study did not, however, concur with Hengstler et al (1982), who posited that rank may mask sex inequity. Here, removing rank removed the effect of sex as well, along with the effect of librarian status. What rank apparently did mask was the effect of highest degree, which became a significant factor in the model only after rank was repressed. This study thus found no evidence to support the contention that rank and tenure should be excluded from salary predictor models.

These findings may be limited by the very small size of the sex effect at the campus studied. Another campus with a more pronounced sex effect might find a more distinctive relationship among rank, sex, and salary. Clearly further research is needed in this area.

While these models are accurate enough to be usable, further research would enhance their usefulness. A more direct measure of previous experience, for example, would be more useful than the proxy variable year of birth. Adding year of appointment to current rank might also be helpful.

The success of this model indicates that similar models could be

developed at other institutions, even those with limited personnel data bases. Similar models could also be developed to uncover possible salary inequities in other employee cohorts: managers, secretaries, and maintenance staff, for example.

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